

66/21/01



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## UTILITY PATENT APPLICATION TRANSMITTAL

Submit an original and a duplicate for fee processing  
(Only for new nonprovisional applications under 37 CFR §1.53(b))

## ADDRESS TO:

Assistant Commissioner for Patents  
Box Patent Application  
Washington, D.C. 20231

Attorney Docket No. 400396/YPLEE

First Named Inventor Youn-han CHANG et al.

10/12/99



## APPLICATION ELEMENTS

1. ☒ Transmittal Form with Fee
2. ☒ Specification (including claims and abstract) [Total Pages 9]
3. ☒ Drawings [Total Sheets 3]
4. ☒ Combined Declaration and Power of Attorney [Total Pages 3]
  - a. ☒ Newly executed
  - b. ☐ Copy from prior application

**[Note Box 5 below]**

  - i. ☐ Deletion of Inventor(s) Signed statement attached deleting inventor(s) named in the prior application
5. ☐ Incorporation by Reference: The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ☐ Microfiche Computer Program
7. ☐ Nucleotide and/or Amino Acid Sequence Submission
  - a. ☐ Computer Readable Copy
  - b. ☐ Paper Copy
  - c. ☐ Statement verifying above copies

## ACCOMPANYING APPLICATION PARTS

8. ☒ Assignment Papers (cover sheet and document(s))
9. ☐ Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure Statement (IDS)
  - ☐ Form PTO-1449
  - ☐ Copies of References
12. ☒ Preliminary Amendment
13. ☒ Return Receipt Postcard (Should be specifically itemized)
14. ☐ Small Entity Statement(s)
  - ☐ Enclosed
  - ☐ Statement filed in prior application; status still proper and desired
15. ☒ Certified Copy of Priority Document(s)
16. ☐ Other:

17. If a **CONTINUING APPLICATION**, check appropriate box and supply the requisite information in (a) and (b) below:
- (a) ☐ Continuation ☐ Divisional ☐ Continuation-in-part of prior application Serial No. \_\_\_\_\_  
Prior application information: Examiner \_\_\_\_\_; Group Art Unit: \_\_\_\_\_
- (b) Preliminary Amendment: Relate Back - 35 USC §120. The Commissioner is requested to amend the specification by inserting the following sentence before the first line:  
"This is a ☐ continuation ☐ divisional of copending application(s)  
☐ Serial No. \_\_\_\_\_, filed on \_\_\_\_\_  
☐ International Application, filed on \_\_\_\_\_, and which designates the U.S."

## APPLICATION FEES

APPLICATION FEES				
BASIC FEE				\$760.00
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total Claims	4	-20=	0	x \$18.00 \$00.00
Independent Claims	1	- 3=	0	x \$78.00 \$00.00
<input type="checkbox"/> Multiple Dependent Claims(s) if applicable				+\$260.00 \$00.00
Total of above calculations =				\$760.00
Reduction by 50% for filing by small entity =				\$(00.00)
<input checked="" type="checkbox"/> Assignment fee if applicable				+ \$40.00 \$40.00
TOTAL =				\$800.00

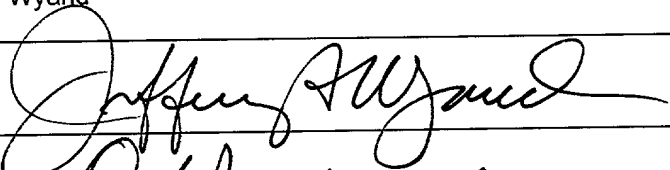
## UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket No. 400396/YPLEE

19. ☐ Please charge my Deposit Account No. 12-1216 in the amount of \$ .
20. ☒ A check in the amount of \$800.00 is enclosed.
21. The Commissioner is hereby authorized to credit overpayments or charge any additional fees of the following types to Deposit Account No. 12-1216:
- a. ☒ Fees required under 37 CFR §1.16.
- b. ☒ Fees required under 37 CFR §1.17.
22. ☒ The Commissioner is hereby generally authorized under 37 CFR §1.136(a)(3) to treat any future reply in this or any related application filed pursuant to 37 CFR §1.53 requiring an extension of time as incorporating a request therefor, and the Commissioner is hereby specifically authorized to charge Deposit Account No. 12-1216 for any fee that may be due in connection with such a request for an extension of time.

## 23. CORRESPONDENCE ADDRESS

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Name	Jeffrey A. Wyand
Signature	
Date	October 12, 1999

UTILITY (Rev. 8/30/1999)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

CHANG et al.

Serial No.:

Filed: October 12, 1999

For: LITHIUM POLYMER BATTERY

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents  
Washington, D. C. 20231

Dear Sir:

Prior to examination, Applicants request that the referenced patent application be amended as shown below.

IN THE DRAWINGS

The Examiner is requested to approve the changes to Figures 1 and 3 as indicated in the attached Request for Approval of Drawing Amendment.

IN THE SPECIFICATION

Page 1, line 5, change "enhanced" to --improved--;

line 8, change "a camcorder" to --camcorders--;

change "phone" to --phones--;

change "computer" to --computers--;

line 11, change "batter" to --battery--;

line 18, change "lightweight" to --light weight--;

line 19, change "Fig. 1 shows" to --Figs. 1A and 1B

show--;

line 20, change "Fig. 1" to --Figs. 1A and 1B--;

Page 2, line 3, change "by Doctor-blade method" to --with a  
doctor blade--;

line 21, change "burr" to --burrs--;

Page 3, line 8, after "mesh," insert --a--;

line 12, delete "formed in";

line 13, delete "form";

line 17, delete "formed";

line 19, delete "formed";

line 22, delete "formed of";

line 27, change "Fig. 1 is a" to --Figs. 1A and 1B

are--;

change "view" to --views--;

Page 4, line 1, change "Fig. 3 is a" to --Figs. 3A and 3B  
are--;

line 1, change "view" to --views--;  
line 17, change "Fig. 3" to --Figs. 3A and 3B--;  
line 18, delete "formed";  
line 21, delete "formed";  
line 26, delete "formed of";  
line 27, delete "formed of";  
line 31, after "22a" insert --,--;

Page 5, line 12, change "coated on" to --applied to--;

line 13, change "by the Doctor-blade method" to  
--using a doctor blade to form coatings--;

line 25, change "by the Doctor-blade method" to  
--using a doctor blade--;

line 29, change "above" to --described--;

Page 6, line 1, after "of" (second occurrence) insert --a--;

line 7, change "3" to --3B--;

line 12, delete "a Cu";

change "metal" to --Cu--;

line 13, delete "a";

line 26, change "formed of an" to --of--;

line 28, after "Then," insert --the--;

delete "then";

Page 7, line 11, change "process" to --processing--;

line 12, change "coated directly onto" to --applied  
directly to--.

IN THE CLAIMS

Claim 1 (Amended), line 3, delete "formed";  
line 6, delete "formed".

Claim 2 (Amended), line 2, delete "formed of".

Claim 3 (Amended), line 2, delete "formed of";  
delete "or punched metal".

Claim 4 (Amended), line 2, change "formed by coating" to  
--coatings of--.

Please add the following claim:

5. The lithium polymer battery of claim 1, wherein the  
positive collector is punched metal.

IN THE ABSTRACT

Line 4, delete "formed";  
Line 6, delete "formed";  
change "on" (second occurrence) to --one--.

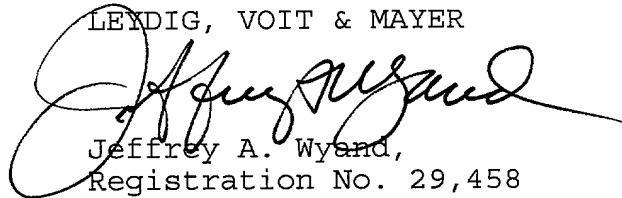
REMARKS

The foregoing changes are made to improve the form of the patent application. No new matter has been added and entry is respectfully requested.

A favorable Action on the merits is solicited.

Respectfully submitted,

LEYDIG, VOIT & MAYER



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# LITHIUM POLYMER BATTERY

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to a lithium (Li) polymer battery, and more particularly, to a Li polymer battery having an enhanced negative plate structure.

### 2. Description of the Related Art

A rechargeable secondary battery is widely used in portable wireless electric apparatus such as a camcorder, cellular phone and lap-top computer. There are various secondary batteries including a nickel-cadmium (Ni-Cd) battery, a lead acid battery, a nickel metal hydride (Ni-MH) battery, a lithium (Li) ion battery, a Li polymer batter, a metal Li secondary battery and the like.

In particular, the metal Li secondary battery has a driving voltage of 3.6 V, a life span longer than that of the Ni-Cd battery or the Ni-MH battery, and high energy density to weight ratio, so its use is gradually expanding.

The Li secondary battery is classified into a Li-ion battery using a liquid electrolyte and a Li polymer battery using a polymer solid electrolyte, according to the type of electrolyte. The Li polymer battery can be embodied into various shapes as opposed to the Li-ion battery, and has merits of high stability and lightweight.

FIG. 1 shows the structure of a Bellcore Li polymer battery, a type of a Li polymer battery. Referring to FIG. 1, a positive plate 11 and a negative plate 12 are stacked with a separator 13 interposed therebetween, each having a multilayered structure. The positive plate 11 consists of a positive collector 11a having a plurality of openings h1, and positive sheets 11b attached to both surfaces of the positive collector 11a. Also, the negative plate 12 consists of a negative collector 12a having a plurality of openings h2 and negative sheets 12b attached to both surfaces of the negative collector 12a. The positive and negative collectors 11a and 12a are formed of expanded metal.

A manufacturing process of the Bellcore Li polymer battery having the above structure will be described.



First, acetone as a solvent, a positive or negative active material, a binder, a conductive material and a plasticizer are mixed to prepare a slurry. Then the slurry is deposited on a polyethylene (PET) base film by a Doctor-blade method to form a thin sheet, the PET base film is removed to obtain an electrode sheet formed of the corresponding active material. Then, both surfaces of the electrode sheets are laminated to each collector at a high temperature by applying pressure, and then cut to a predetermined size.

The resulting positive and negative plates 11 and 12 are combined with the separator 13 interposed therebetween, and the stacked structure is laminated further at a high temperature by applying pressure, thereby resulting in a bi-cell structure. Then, the bi-cell structure is soaked in ether to extract the plasticizer. Then an electrode assembly is formed having a 9 layer bi-cell structure. Then, positive and negative terminals are welded onto the assembly, and electrolyte is infiltrated into the empty space from which the plasticizer has been extracted. Finally, a casing is formed around the resulting product.

In the conventional Li polymer battery completed by the above method, the positive and negative collectors 11a and 12a require the openings h1 and h2 through which the plasticizer is extracted, so manufacturing the positive and negative collectors 11a and 12a is complicated. Also, adhesive forces between the positive collector 11a and the positive sheets 11b and between the negative collector 12a and the negative sheets 12b become weak due to burr generated during the formation of the openings h1 and h2. In addition, the thicknesses of the positive and negative plates 11 and 12 are nonuniform.

Also, when attaching the electrode sheets 11b and 12b to the positive and negative collectors 11a and 12a, respectively, bubbles may form in the spaces between the sheet and collector due to the openings h1 and h2, thereby lowering conductivity of the positive and negative collectors 11a and 12a.

Also, the expanded metal forming the positive and negative collectors 11a and 12a is supplied in a roll having a width of less than 300mm. The expanded metal has the property of being extendible in a longitudinal direction by force. Thus, it is difficult to manufacture the positive and negative collectors 11a and 12a through a continuous process by applying tensile strength.

In general, the material of the collectors determine the cost of the battery. Thus, using the expanded metal as a material for the collectors increases the cost of the battery, compared to using punched metal.

Also, as the expanded metal is mechanically processed, the metal itself is subject to stress. That is, when the expanded metal is cut in a predetermined size, fine powder of arsenic acid is separated from the collector made of the expanded metal. Also, because the collector made of the expanded metal is in the form of a mesh, burr is generated due to expansion of strands in the mesh, thereby causing an electrical short circuit.

### SUMMARY OF THE INVENTION

To solve the above problems, it is an object of the present invention to provide a lithium (Li) polymer battery in which a negative collector is formed in a foil form without openings, thereby improving the performance of plates and the productivity of the battery.

Accordingly, to achieve the above object, there is provided a lithium (Li) polymer battery comprising: a positive plate including a positive collector having a plurality of openings and a positive active material layer formed on at least one surface of the positive collector; a negative plate including a negative collector in a foil form, and a negative active material layer formed on at least on surface of the negative collector; and a separator between the positive and negative plates, for insulating the positive and negative plates.

Preferably, the negative collector is formed of a copper (Cu) foil.

### BRIEF DESCRIPTION OF THE DRAWINGS

The above object and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a partial sectional view of an electrode assembly of a conventional lithium (Li) polymer battery;

FIG. 2 is an exploded perspective view of a Li polymer battery according to the present invention; and

FIG. 3 is a partial sectional view of an electrode assembly shown in FIG. 2.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 2, a lithium (Li) polymer battery according to the present invention comprises an electrode assembly 20, a lower case 31 having a receiving portion 32 for holding the electrode assembly 20, and an upper case 33 which covers the receiving portion 32 to seal the electrode assembly 20.

The electrode assembly 20 is formed by repeatedly stacking a positive plate 21 and a negative plate 22 with a separator 23 interposed therebetween, and positive taps 26a and negative taps 24a are extended from the positive plates 21 and the negative plates 22, respectively.

The positive taps 26a and the negative taps 24a form a positive tap bundle 26 and a negative tap bundle 24 respectively, which are connected to a positive terminal 25 and a negative terminal 27 respectively. The positive terminal 25 and the negative terminal 27 are drawn out of the case when the electrode assembly 20 is put in the receiving portion 32 of the lower case 31 and the receiving portion 32 is then covered by the upper case 33.

Referring to FIG. 3, the positive plate 21 consists of a positive collector 21a having a plurality of openings H and a positive active material layer 21b formed on at least one surface of the positive collector 21a. Also, the negative plate 22 consists of a negative collector 22a in a foil form and a negative active material layer 22b formed on at least one surface of the negative collector 22a. The positive plate 21 is combined with the negative plate 22 with the separator 23 interposed therebetween in order to insulate the plates 21 and 22, forming a cell. Then, such a cell is repeatedly stacked to form the electrode assembly 20.

According to the present invention, preferably, the negative collector 22a is formed of a copper (Cu) foil without openings, and the positive collector 21a is formed of expanded metal or punched metal containing aluminum (Al), and has a plurality of openings H.

The positive plate 21 and the negative plate 22 are obtained by depositing a positive active material slurry and a negative active material slurry on both surfaces of positive collector 21a and negative collector 22a respectively. The negative

active material slurry is prepared by dissolving (10% total volume) polyvinylidene fluoride (PVDF) as a binder in N-methyl-2-pyrrolidone (NMP) and adding (18% total volume) plasticizer, (2% total volume) carbon black as a conductive material and (70% total volume) carbon as a negative active material to the solution, and then stirring the mixture until it reaches a viscosity of 20,000~30,000 centipoise (cps).

Also, the positive active material slurry is prepared by dissolving (10% total volume) PVDF as a binder in acetone, adding (15~18% total volume) plasticizer, (2~5% total volume) carbon black as a conductive material and (70% total volume)  $\text{LiCoO}_2$  as a positive active material to the solution, and then stirring the mixture until it reaches a viscosity of 20,000cps.

Preferably, the prepared negative and positive active material slurries are directly coated on both surfaces of the respective negative and positive collectors 22a and 21a by the Doctor-blade method.

According to another preferred embodiment, a positive active material slurry is prepared by dissolving (10% total volume) PVDF as a binder in acetone, adding (15~18% total volume) plasticizer, (2~5% total volume) carbon black as a conductive material and (70% total volume)  $\text{LiCoO}_2$  as a positive active material to the solution, and then stirring the mixture until it reaches a viscosity of 20,000cps.

Also, a negative active material slurry is prepared by dissolving (10% total volume) PVDF as a binder in acetone, adding (15~18% total volume) plasticizer, (2~5% total volume) carbon black as a conductive material and (70% total volume) carbon as a negative active material to the solution, and then stirring the mixture until it reaches a viscosity of 20,000cps.

Then, the prepared positive and negative active material slurries are made into thin sheets, e.g., by the Doctor-blade method, and then the resulting sheets are attached to both surfaces of the respective positive and negative collectors 21a and 22a.

The amount of the materials contained in the positive and negative active material slurries can be varied without limitation to the above embodiments.

According to the present invention, the Cu foil without openings is adopted as the negative collector 22a, so that electrical conductivity is improved, adhesive force during the laminating on the negative collector 22a with the active material layer 22b

is strong, and the thickness of the negative plate is uniform. Also, generation of burr or bubbles between the conventional negative collector and negative sheet, caused by the openings, can be prevented.

In addition, even though the negative collector 22a has no openings, the plasticizer contained in the negative plate 22 and the separator 23 can be extracted through the openings H of the positive collector 21a in the direction indicated by the arrows in FIG. 3.

Such effect of the present invention can be understood more fully through the following experiments.

#### [Experimental Example 1]

The amount of plasticizer extracted from the conventional battery adopting the negative collector 12a which is made of a Cu expanded metal and has openings was compared with that of the battery adopting a Cu foil as the negative collector 22a according to the present invention. Here, each electrode assembly had a 9-layer bi-cell structure, and (15% total volume) the plasticizer was used for the preparation.

As a result, the amount of plasticizer extracted from the conventional battery was approximately 3.4801g, and that from the battery according to the present invention was approximately 3.4526g, which were nearly the same. That is, it can be understood that the amount of plasticizer extracted from the battery is not decreased even though the Cu foil without openings is adopted as a negative collector.

#### [Experimental Example 2]

A positive sheet having a thickness of approximately 80 $\mu$ m and a negative sheet having a thickness of approximately 120 $\mu$ m were respectively attached to the positive collector 21a formed of an Al expanded metal, and the negative collector 22a formed of a Cu foil having a thickness of 20 $\mu$ m, to obtain a battery according to the present invention. Then, resistance of the battery was measured and then compared with that of the conventional battery.

As a result, the resistance of the battery according to the present invention was 50~60mΩ while that of the conventional battery was 80~100mΩ. That is, it can be understood that the electrical conductivity of the Li polymer battery according to the present invention increases as the contact area between the electrode negative sheet and the negative collector increases.

Also, the adhesive force of the negative plate was increased to 18gf/mm<sup>2</sup> or more compared to 10gf/mm<sup>2</sup> of the conventional negative plate. As a result, the life span of the battery was increased by approximately 7% or more with respect to the conventional battery, and the energy density of the battery increased by 5~10%.

In addition, because a foil having a comparatively large tensile strength is used as a negative collector, manufacturing through continuous process is possible. Also, the negative active material slurry can be coated directly onto the negative collector, so that manufacture of the plate is simplified.

What is claimed is:

1. A lithium (Li) polymer battery comprising:
  - a positive plate including a positive collector having a plurality of openings and a positive active material layer formed on at least one surface of the positive collector;
  - a negative plate including a negative collector in a foil form, and a negative active material layer formed on at least on surface of the negative collector; and
  - a separator between the positive and negative plates, for insulating the positive and negative plates.
2. The lithium polymer battery of claim 1, wherein the negative collector is formed of a copper (Cu) foil.
3. The lithium polymer battery of claim 1, wherein the positive collector is formed of expanded metal or punched metal.
4. The lithium polymer battery of claim 2, wherein the positive and negative active material layers are formed by coating positive and negative active material slurries, respectively, on at least one surface of the positive collector and at least one surface of the negative collector.

### Abstract of the Disclosure

A lithium (Li) polymer battery is provided. The Li polymer battery includes: a positive plate including a positive collector having a plurality of openings and a positive active material layer formed on at least one surface of the positive collector; a negative plate including a negative collector in a foil form, and a negative active material layer formed on at least on surface of the negative collector; and a separator between the positive and negative plates, for insulating the positive and negative plates.



FIG. 1 (PRIOR ART)

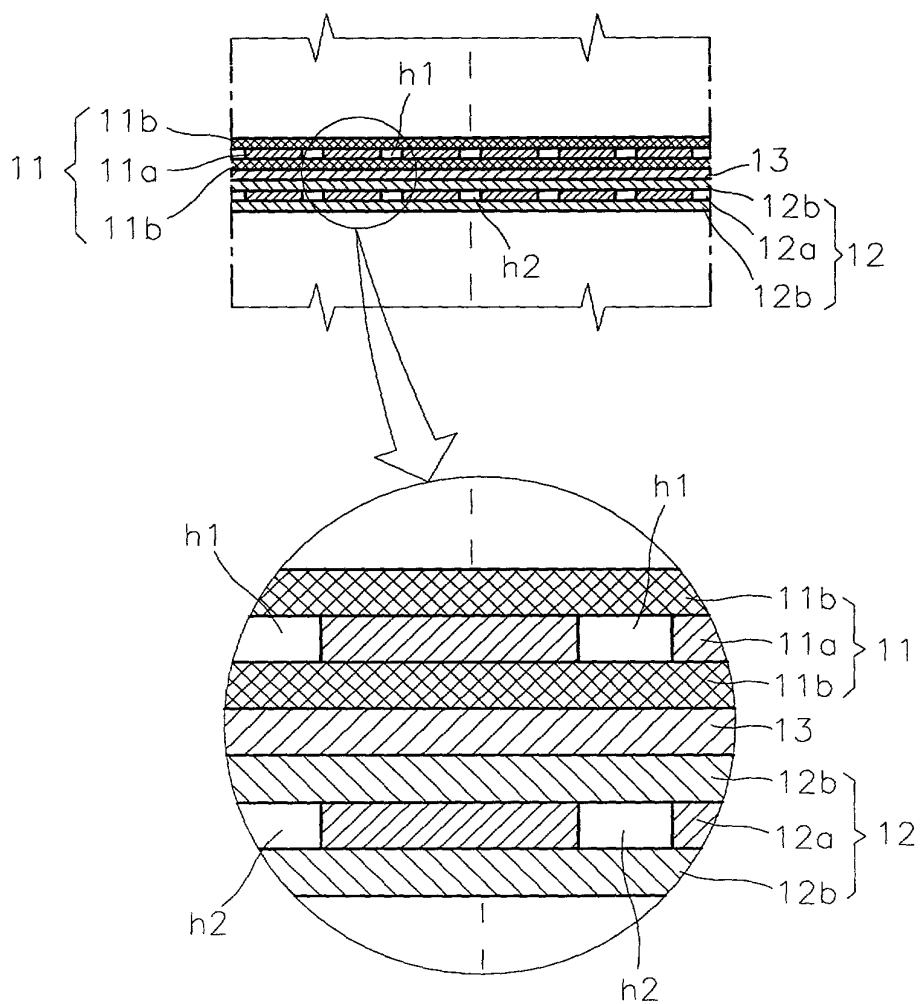


FIG. 2

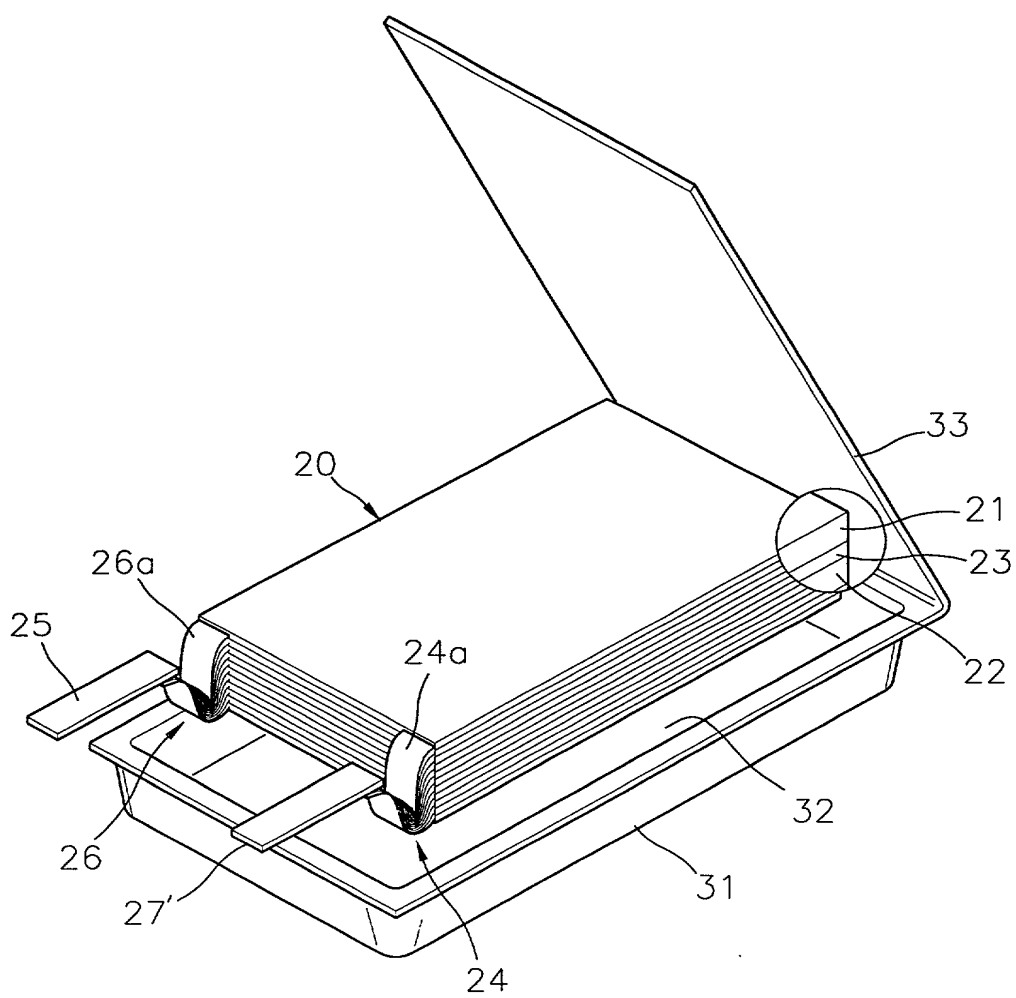
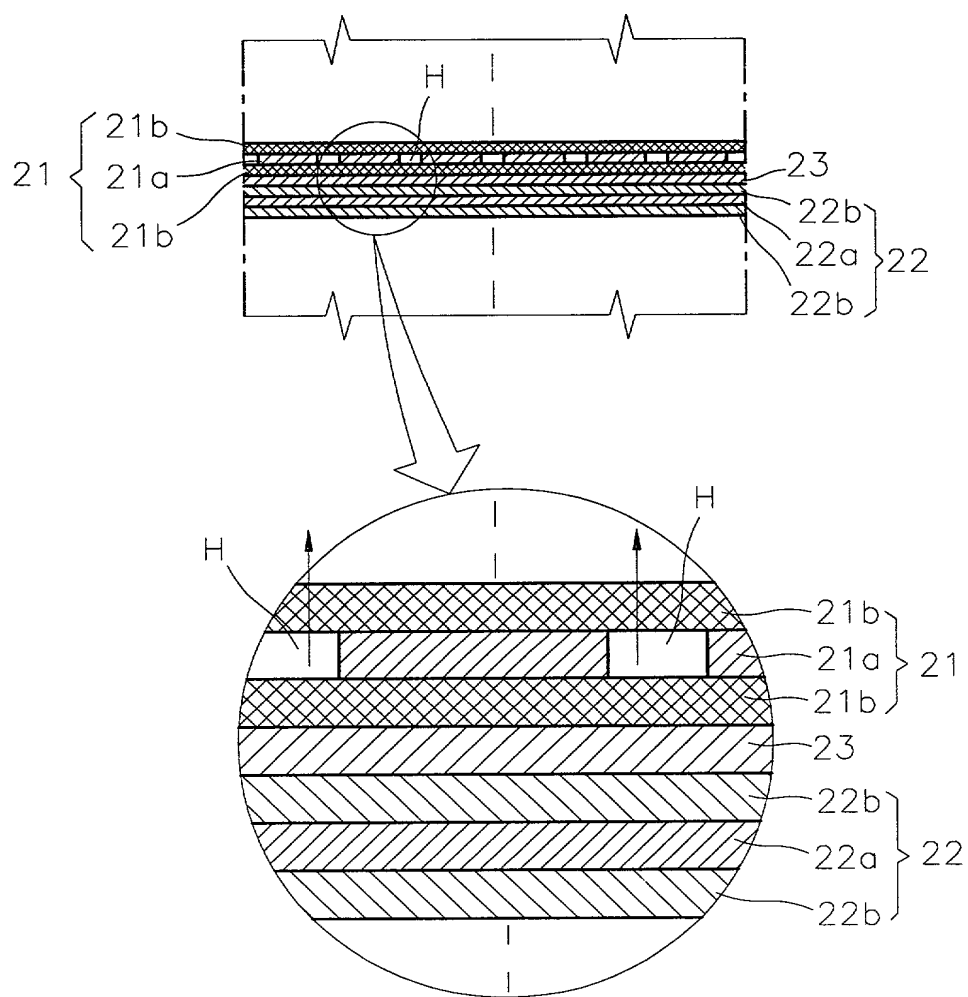


FIG. 3



## COMBINED DECLARATION AND POWER OF ATTORNEY

This declaration is of the following type:

- ☒ original   ☐ design   ☐ supplemental  
☐ national stage of PCT  
☐ divisional   ☐ continuation   ☐ continuation-in-part

As a below named inventor, I hereby declare that

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first, and sole inventor (*if only one name is listed below*) or an original, first, and joint inventor (*if plural names are listed below*) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

LITHIUM POLYMER BATTERY

the specification of which:

- ☒ is attached hereto.  
☐ was filed on \_\_\_\_\_ as Serial No. \_\_\_\_\_ and was amended on \_\_\_\_\_ (*if applicable*).  
☐ was described and claimed in PCT International Application No. PCT/\_\_\_\_\_ filed on \_\_\_\_\_ and as amended pursuant to PCT Article 19 on \_\_\_\_\_ (*if any*).

I state that I have reviewed and understand the contents of the specification identified above, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information that is material to the examination of the application identified above in accordance with 37 CFR §1.56.

I claim foreign priority benefits pursuant to 35 USC §119(a) of any foreign application(s) for patent or inventor's certificate or of any PCT international patent application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent, utility model, design registration, or inventor's certificate or any PCT international patent application(s) designating at least one country other than the United States of America filed by me for the same invention and having a filing date before that of the application(s) from which the benefit of priority is claimed.

PRIOR FOREIGN PATENT, UTILITY MODEL, AND DESIGN REGISTRATION APPLICATIONS, BENEFIT CLAIMED UNDER 35 USC §119(a)						
COUNTRY	PRIOR FOREIGN APPLICATION	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC §119(a)			
Rep. of Korea	98-42711	13/10/1998	x	YES		NO
				YES		NO
				YES		NO

I claim the benefit pursuant to 35 USC §119(e) of the following United States provisional patent application(s)

PRIOR U.S. PROVISIONAL PATENT APPLICATIONS, BENEFIT CLAIMED UNDER 35 USC §119(e)	
APPLICATION NO.	DATE OF FILING (day,month,year)

I claim the benefit pursuant to 35 USC §120 of any United States patent application(s) or PCT international patent application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this patent application is not disclosed in the prior patent application(s) in the manner provided by the first paragraph of 35 USC §112, I acknowledge the duty to disclose material information as defined in 37 CFR §1.56 effective between the filing date of the prior patent application(s) and the national or PCT international filing date of this patent application.

PRIOR U.S. PATENT APPLICATIONS OR PCT INTERNATIONAL PATENT APPLICATIONS DESIGNATING THE U.S., BENEFIT CLAIMED UNDER 35 USC §120					
U.S. PATENT APPLICATIONS			Status (check one)		
SERIAL NUMBER	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
1.					
2.					
3.					
PCT APPLICATIONS DESIGNATING THE U.S.			Status (check one)		
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NOS. ASSIGNED (if any)	PATENTED	PENDING	ABANDONED
4.					
5.					
6.					

As a named inventor, I appoint the following attorneys to prosecute this application and transact all business in the Patent and Trademark Office connected with this patent application.

John M. Belz, Reg. 30,359  
Jeffrey A. Wyand, Reg. 29,458  
Jeremy M. Jay, Reg. 33,587

Michael H. Tobias, Reg. 32,948  
Gregory A. Hunt, Reg. 41,085

Patrick R. Jewik, Reg. 40,456  
Joseph S. Ostroff, Reg. 39,321

I further direct that correspondence concerning this application be sent to:

LEYDIG, VOIT & MAYER, LTD.  
700 Thirteenth Street, N.W., Suite 300  
Washington, D.C. 20005  
Telephone (202) 737-6770

I authorize my attorneys to accept and follow instructions from \_\_\_\_\_ regarding any matter related to the preparation, examination, grant, and maintenance of the patent application identified above, any continuation, continuation-in-part, or divisional patent application based on the patent application identified above, and any patent issuing from that patent application, until I or my assigns withdraw this authorization in writing

I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Youn-han Chang

Inventor's signature Chang Youn Han

Date 1999. 4. 14

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Full name of second joint inventor, if any: Jung-ho Kim

Inventor's signature [Signature]

Date 1999. 4. 14

Country of Citizenship: Korean

Residence: Suwon-city, Kyungki-do, Rep. of Korea

Post Office Address: 575 Shin-dong, Paldal-gu, Suwon-city,  
Kyungki-do, Rep. of Korea

Full name of third joint inventor, if any:

Inventor's signature \_\_\_\_\_

Date \_\_\_\_\_

Country of Citizenship:

Residence:

Post Office Address: